Gerry Smith

* See dry placers

Keep at cabin

SPECIAL SUPPLEMENT

to

Mineral Information Service

December 1963

BASIC PLACER MINING

ELEMENTARY PLACER MINING METHODS*

CONTENTS

ILLUSTRATIONS

Commercial gold mining in California touched a new post-war low during 1963, owing to rising operating costs and the fixed price for gold, but the public interest in placer mining continues unabated. Each day the Division receives letters of inquiry from students, week-end prospectors, vacationists, tourists and retired hobbyists, desiring to follow the footsteps of the argonauts and seeking guideposts along the way.

The fortyniners prospected and mined very efficiently throughout the state. They were followed by the Chinese miners whose thoroughness in mining has become a byword, and by many generations of prospectors during the succeeding hundred years. Thus it must be remembered that few, if any, virgin placers exist in California today. Most gold along rivers and streams within easy reach is new gold washed down from the hills each winter or gold lost from earlier operations.

Nevertheless a hard-working prospector willing to toil long hours can still recover from 50 cents to a dollar a day in gold, or about $100 a season. Anyone hoping to find unworked ground where greater rewards may be won must be prepared to prospect the rougher backwoods country and side streams far removed from our modern highways. Very little inducement is offered the amateur lacking in funds to prospect for gold in the hope of thereby making a living.

Land Open to Placering

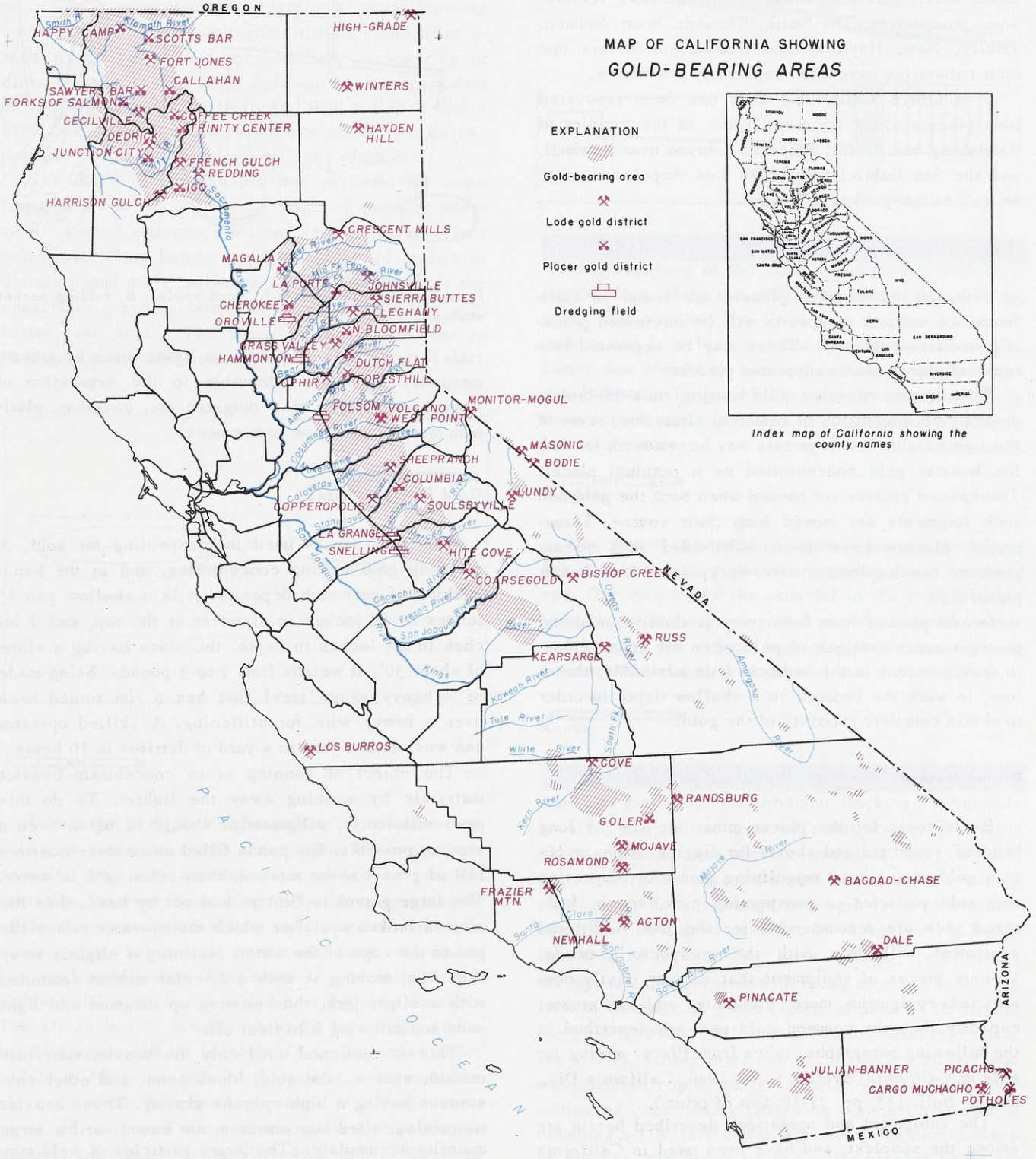
Although permission of the owner is required to prospect on private property, no such permission is required to prospect on unreserved vacant public land of the United States. Information on land ownership can be obtained from the plat maps in the offices of the county assessors. Unfortunately, these maps do not distinguish between parts of the public lands open to prospecting and parts that already have been claimed. Since surveys of claimed lands are not required until the property passes to patent or private ownership, their exact location may be unknown. The safest procedure, therefore, for week-end prospectors and vacationists is to obtain permission from the residents on the property they wish to pan or prospect.

The more experienced and professional prospectors usually have time to examine also the records of unpatented mining claims in the offices of the county recorder, and the records of patented mining claims in the offices of the U.S. Bureau of Land Management, Sacramento or Riverside. Public land thus determined to be open can be prospected and when a mineral discovery is made, the land can be located as explained in the Division's *Legal Guide for California Prospectors and Miners.*

Placer Mining Areas

The most productive gold mining areas of the state are located along the west slope of the Sierra Nevada. Areas favorable to placer mining extend upstream along the Sierran streams from the points where they enter the Great Valley of California to elevations of about 5000 feet. The middle fork of the American River and branches of the Feather River in Plumas County have been mined successfully almost to their sources. Eastward, the granite area which forms the core and crest of the range is generally unfavorable.

* *Revised from Mineral Information Service, vol. 10, no. 8, August 1957.*


MAP OF CALIFORNIA SHOWING
GOLD-BEARING AREAS
EXPLANATION
Gold-bearing area
Lode gold district
Placer gold district
Dredging field
Index map of California showing the county names
OREGON
NEVADA
ARIZONA
MEXICO
PACIFIC OCEAN
HAPPY CAMP
SCOTTS BAR
FORT JONES
CALLAHAN
SAWYERS BAR
FORKS OF SALMON
CECILVILLE
COFFEE CREEK
TRINITY CENTER
DEDRICK
JUNCTION CITY
FRENCH GULCH
REDDING
IGO
HARRISON GULCH
HIGH-GRADE
WINTERS
HAYDEN HILL
CRESCENT MILLS
MAGALIA
LA PORTE
JOHNSVILLE
SIERRA BUTTES
CHEROKEE
ALLEGHANY
OROVILLE
N. BLOOMFIELD
GRASS VALLEY
HAMMONTON
DUTCH FLAT
FORESTHILL
HIR
FOLSOM
VOLCANO
WEST POINT
MONITOR-MOGUL
MASONIC
BODIE
SHEEPRANCH
COLUMBIA
LUNDY
COPPEROPOLIS
SOULSBYVILLE
LA GRANGE
SNELLINGS
HITE COVE
COARSEGOLD
BISHOP CREEK
RUSS
KEARSARGE
LOS BURROS
COVE
RANDSBURG
GOLER
MOJAVE
ROSAMOND
FRAZIER MTN.
BAGDAD-CHASE
ACTON
NEWHALL
DALE
PINACATE
JULIAN-BANNER
PICACHO
CARGO MUCHACHO
POTHOLES
Smith R.
Klamath River
Trinity R.
Sacramento River
Mid. Fk. Feather River
Yuba River
North Fk. American River
Middle Fk. American River
South Fk. American River
Cosumnes River
Mokelumne River
Calaveras River
Stanislaus River
Tuolumne River
Merced River
Chowchilla River
Fresno River
San Joaquin River
Kings River
Kaweah River
Tule River
White River
Kern River
South Fk.
Owens River
Amargosa River
Mojave River
Santa Clara River
San Gabriel
Santa Ana River

Another important placer mining area is located in the Klamath Mountains in the northern part of the state. The relative inaccessibility and sparseness of population render this area attractive to the more venturesome prospectors. The Smith, Klamath, Scott, Salmon, Trinity, New, Hayfork, and Sacramento Rivers and their tributaries have been especially productive.

In southern California, gold has been recovered from placers along the Kern River; in the vicinity of Randsburg and Atolia; Placerita Canyon near Newhall, and the San Gabriel Canyon in Los Angeles County, as well as many other localities.

Types of Placers

Although buried-river placers are found in California the amateur prospector will be interested primarily in surface placers. These may be separated into residual placers and transported placers.

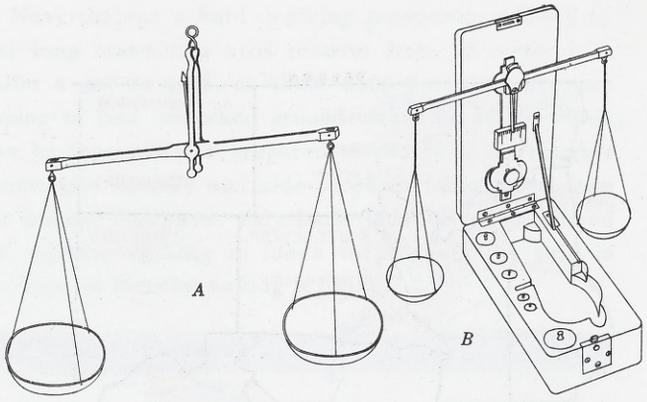
When quartz or other gold-bearing rock is broken down by disintegration or chemical alteration, some of the lightweight rock fragments may be removed, leaving the heavier gold concentrated as a residual placer. Transported placers are formed when both the gold and rock fragments are moved from their source. Transported placers have been subdivided into stream placers, bench placers, river-bar placers and beach placers.

Stream placers have been very productive, and the greatest concentrations of gold often are found close to or in crevices in the bedrock. It is advisable, therefore, to work the bedrock to a shallow depth in order to obtain complete recovery of the gold.

Mining Methods

Basic tools for the placer miner are few. A long handled, round-pointed shovel for digging, a 16- or 18-inch gold pan, a hand magnifying glass for inspecting tiny gold particles, a prospecting pick, and a full-sized pick are recommended for the job. Additional equipment will vary with the prospector's needs. Various pieces of equipment that may be easily constructed—equipment more elaborate and of greater capacity than the common gold pan—are described in the following paragraphs, taken from *Placer mining for gold in California* (Averill, C.V., 1946, California Div. Mines Bull. 135, pp. 21-30. Out of print.).

The equipment and operations described herein are among the simplest, and have been used in California to recover gold from placers since the days of '49. They are used not only for gold, but for heavy materials that may be separated from lighter ones by gravity methods. They are adaptable to the separation of cassiterite (stream tin), tungsten ore, cinnabar, platinum metals, and some gem stones.



Prospector's gold scales: A, hand scales; B, folding pocket scales.

Gold Pan and Batea

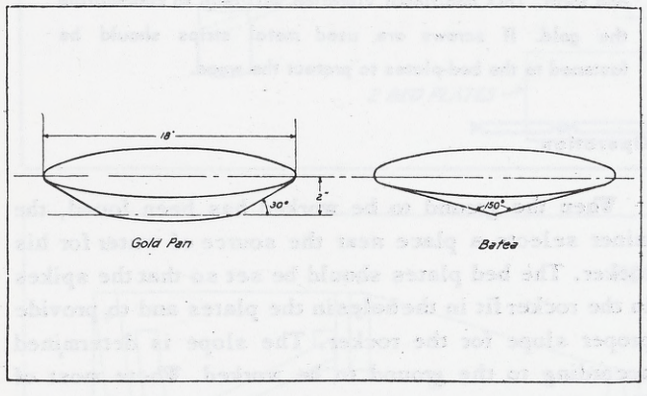
The gold pan is used in prospecting for gold, in cleaning gold-bearing concentrates, and in the hand-working of very rich deposits. It is a shallow pan 15 inches to 18 inches in diameter at the top, and 2 inches to 2½ inches in depth, the sides having a slope of about 30°. It weighs from 2 to 3 pounds, being made of a heavy gauge steel that has a rim turned back over a heavy wire for stiffening. A skilled operator can wash half a yard to a yard of detritus in 10 hours.

The object of panning is to concentrate heavier materials by washing away the lighter. To do this most efficiently, all material should be of as even a size as possible. The pan is filled about three-quarters full of gravel to be washed, then submerged in water. The large gravel is first picked out by hand, then the clay is broken up, after which the operator raises the pan to the edge of the water, inclining it slightly away from him, moving it with a circular motion combined with a slight jerk, thus stirring up the mud and light sand and allowing it to float off.

This is continued until only the heavier materials remain, such as the gold, black sand, and other substances having a high specific gravity. These heavier materials, called concentrates, are saved until a large quantity accumulates. The larger particles of gold may be extracted by hand, the smaller amalgamated with quicksilver, preferably in a copper-bottomed pan. If

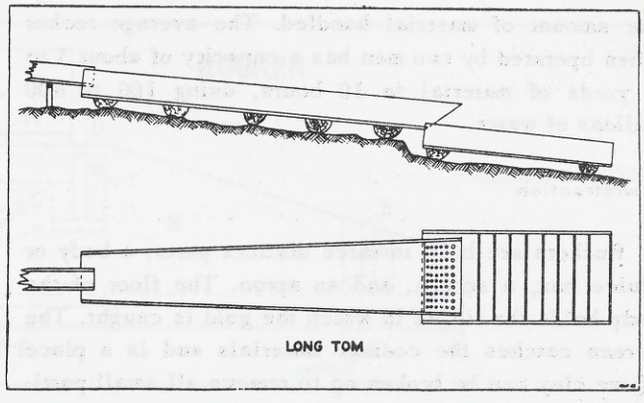
the separation is extremely difficult and the quality and quantity justify, the concentrates may be shipped to a smelter. Panning may best be learned by watching an old-timer or experienced operator at work, learning certain tricks of the trade from him. A clean 6- or 8-inch frying pan makes an excellent prospecting or clean-up pan. It is well to burn out an iron pan after having used quicksilver in it, and then polish it with a soft rock or piece of brick; otherwise, it may be impossible to see small colors or flakes of gold.

The batea is cone-shaped and performs the same function as a pan. It may be made of wood or sheet metal; a wood chopping bowl may serve as an excellent substitute. Most bateas are from 15 to 24 inches in diameter and have an angle of 150° to 155° at the apex. Many persons claim that wood will hold fine gold better than metal. The batea is in common use in Mexico, Central and South America, and Asia.



Long Tom

A long tom is an inclined trough used to concentrate gold from auriferous earths and gravels. It has a greater capacity than a rocker, but also uses more water in operation, because flowing water is the carrying agent of the finer materials. A long tom is usually of crude construction, being built in two sections, the sluice box, and a riffle-box. The slope is generally 1 inch per foot of length, but is varied as conditions warrant. The sluice box is usually about 12 feet long. At the head or upper end, it is about 15 to 24 inches wide, and 24 to 36 inches wide at the tail or lower end. The sides are about 8 inches high at the tail. A screen or piece of perforated sheet metal prevents the coarse material from going to the riffle-box, and at the head end is a flume or iron pipe from which the water is fed. The riffle-box is usually shorter than the sluice box,



and slightly wider at the tail end. It is set just below the first opening in the screen, sometimes with more gentle slope. Here the riffles are placed to catch the gold. The box may be lined with canvas as in the rocker, and it is best to build detachable riffles. The sluice box should be made of 2-inch lumber to withstand abrasion by gravel. The capacity of a long tom is from 4 to 6 yards per man in a 10-hour day, two to four men working.

Operation

The ground to be worked is shoveled into the sluice box and washed by the water coming from the head end. One man works the material in the trough with a fork, taking the coarser gravel out when washed clean and keeping the screen from clogging. Clean-ups are made when necessary, at the end of a day or oftener.

Rocker

The rocker is a machine to save gold from auriferous sand and gravel by concentration. Rockers vary greatly in size, shape, and general construction, depending upon available construction materials, size of gold particles to be recovered and the builder's mining experience. Rockers range in length from 24 to about 60 inches, in width from 12 to 25 inches, and in height from 6 to 24 inches. Some have a single apron, others two aprons, and screens with holes as much as half an inch in diameter. A great variety of devices to recover the gold is used: riffles of all kinds, blanket, carpet, cocoa mat, rubber mat, canvas, cowhide, burlap, and amalgamated copper plate. A fairly efficient and easy method of constructing riffles for a rocker consists of clamping a 3/8-inch metal lath over a double thickness of blanket, the clamp allowing the blanket to be removed easily for cleaning. Of all wet methods for saving placer gold, the rocker uses the least water for

the amount of material handled. The average rocker when operated by two men has a capacity of about 3 to 5 yards of material in 10 hours, using 100 to 800 gallons of water.

Construction

Rockers are built in three distinct parts, a body or sluice box, a screen, and an apron. The floor of the body holds the riffles in which the gold is caught. The screen catches the coarser materials and is a place where clay can be broken up to remove all small particles of gold. The apron is used to carry all material to the head of the rocker, and is made of canvas stretched loosely over a frame. It has a pocket, or low place, in which coarse gold and black sands can be collected.

The drawing opposite shows a portable rocker that is easily built. The six bolts are removed to dismantle the rocker for easy transportation. The material required to construct it is given in the following tabulation:

A. End, one piece 1 in. x 14 in. x 16 in.
B. Sides, two pieces 1 in. x 14 in. x 48 in.
C. Bottom, one piece, 1 in. x 14 in. x 44 in.
D. Middle spreader, one piece 1 in. x 6 in. x 16 in.
E. End spreader, one piece 1 in. x 4 in. x 15 in.
F. Rockers, two pieces, 2 in. x 6 in. x 17 in. (shaped)
H. Screen, about 16 in. square outside dimensions with screen bottom. Four pieces of 1 in. x 4 in. x 15¼ in. and one piece of screen 16 in. square with ¼ in. or ½ in. openings or sheet metal perforated by similar openings.
K. Apron, made of 1 in. x 2 in. strips covered loosely with canvas. For cleats and apron, etc., 27 feet of 1 in. x 2 in. lumber is needed. Six pieces of 3/8 in. iron rod 19 in. long threaded 2 in. on each end and fitted with nuts and washers.
L. The handle, placed on the screen, although some miners prefer it on the body. When on the screen, it helps in lifting the screen from the body.

If 1- by 14-inch boards cannot be obtained, clear flooring tightly fitted will serve, but 12 feet of 1- by 2-inch cleats in addition to that above mentioned will be needed.

A dipper may be made of no. 2½ can and 30 inches of broom handle. Through the center of each of the rockers a spike is placed to prevent slipping during operation. In constructing riffles, it is advisable to build them in such a way that they may be easily removed, so that clean-ups can be made readily. Two planks about 2 by 8 by 24 inches with a hole in the center to hold the spike in the rockers are also required. These are used as a bed for the rockers to work on and to adjust the slope of the bed of the rocker.

Assembly

The parts are cut to size as shown on the drawing. The cleats on parts A, B, C, and D are of 1- by 2-inch material and are fastened with nails or screws. The screen (H) is nailed together and the handle (L) is bolted to one side. Corners of the screen should be reinforced with pieces of sheet metal because the screen is being continually pounded by rocks when the rocker is in use. The apron (K) is a frame nailed together, and canvas is fastened to the bottom. Joints at the corners should be strengthed with strips of tin or other metal.

Parts are assembled as follows: bottom (C), end (A) with cleats inside, middle spreader (D) with cleat toward A, and end spreader (E) are placed in position between the two sides (B) as shown. The six bolts are inserted and the nuts are fastened. Rockers (F) should be fastened to bottom (C) with screws. Apron (K) and screen (H) are set in place, and the rocker is ready for use.

If one-quarter-inch lag screws are driven into the bottom of each rocker about 5 inches from each side of the spike and the heads are allowed to protrude from the wood, a slight bump will result as the machine is worked back and forth. This additional vibration will help to concentrate the gold. If screws are used metal strips should be fastened to the bed-plates to protect the wood.

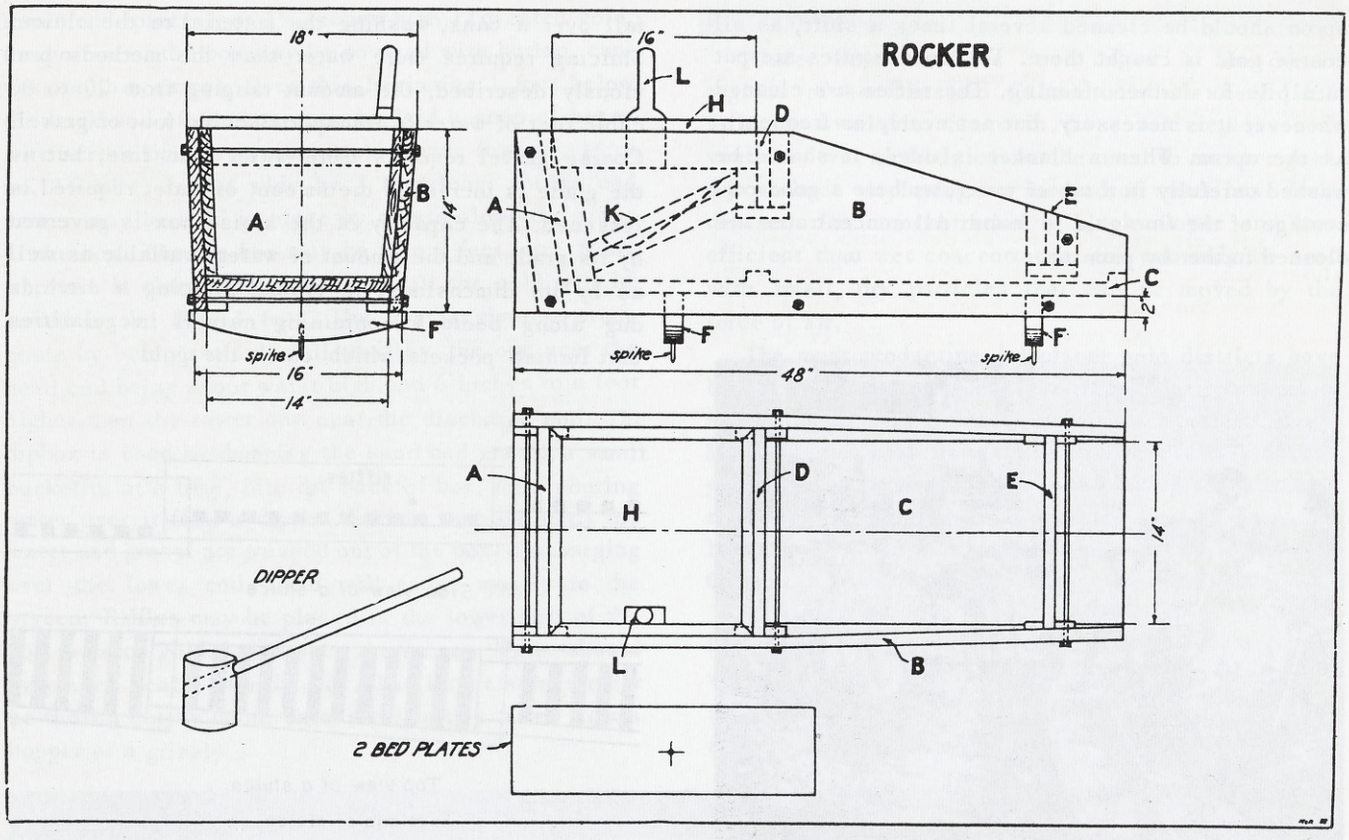
Operation

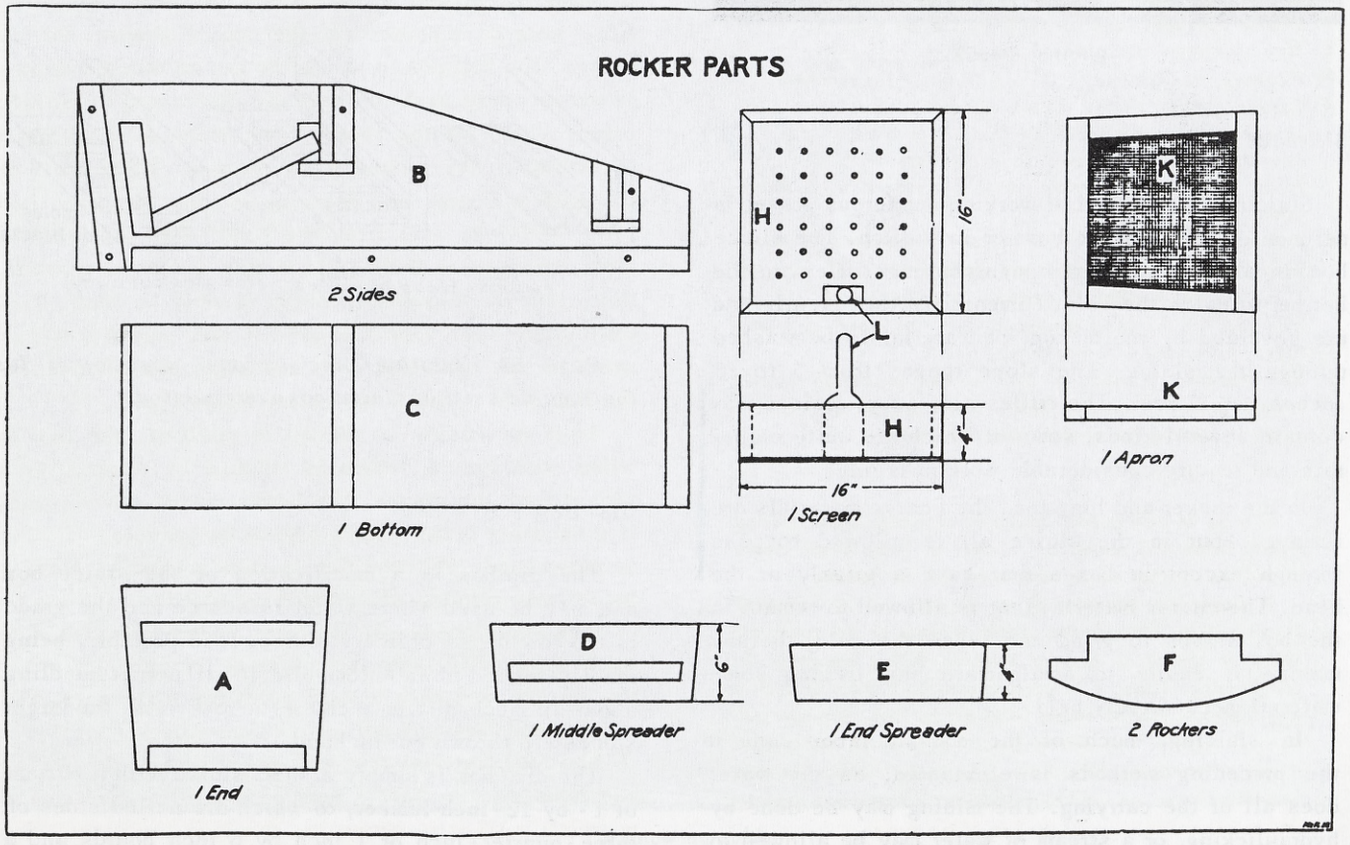
When the ground to be worked has been found, the miner selects a place near the source of water for his rocker. The bed plates should be set so that the spikes in the rocker fit in the holes in the plates and to provide proper slope for the rocker. The slope is determined according to the ground to be worked. Where most of the gold is coarse and there is no clay, the head bed plate should be 2 to 4 inches higher than the tail bed plate; where most of the gold is fine or clay is present, this slope is lessened perhaps to only an inch. It is difficult to save very fine gold if very muddy water is used, as the operation does not allow enough time for the fine gold to settle but rather floats it off.

After the rocker is placed in position, the box is filled with gravel, which is washed by water poured over it from the dipper. The larger gravel, when clean, is picked out either with a fork or by hand and all clay is pulverized. The machine is then rocked vigorously for several minutes while water is added.

It is important to use the right amount of water. Too much water will carry the material through the rocker too quickly, and with it much gold; too little water will make a mud that will not let the fine gold settle.

When all material that will pass through the screen has done so, the box is dumped and this operation is repeated until it is necessary to clean the apron. The


ROCKER
18"
16"
14"
16"
48"
spike
spike
spike
A
B
C
D
E
F
H
K
L
DIPPER
2 BED PLATES


ROCKER PARTS
2 Sides
1 Bottom
1 Screen
1 Apron
1 End
1 Middle Spreader
1 End Spreader
2 Rockers

apron should be cleaned several times a shift, as all coarse gold is caught there. The concentrates are put in a pile for further cleaning. The riffles are cleaned whenever it is necessary, but not nearly as frequently as the apron. When a blanket is used, it should be washed carefully in a tub of water, as here a good percentage of the fine gold is found. All concentrates are cleaned further by panning.

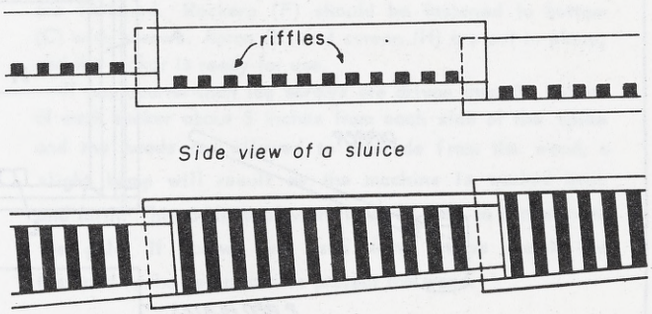
Sluicing in 1852

Sluice-box

Sluicing is a method of working auriferous gravel in a flume called a sluice box, or in a ditch. The sluice box is a crude sloping trough, having riffles on the bottom to catch the gold. Dimensions vary greatly and are governed by the amount of material to be washed through the sluice. The slope ranges from 5 to 18 inches per 12 feet. The riffles also vary; sluices may contain several kinds, some of which are quite elaborate and require considerable work in laying.

In the rocker and long tom, the coarse materials are removed, but in the sluice all is allowed to pass through except in boxes that have a grizzly at the head. The coarse material that is allowed to remain in the box serves to grind and clean the gold, thereby making it easier to amalgamate and freeing some material mechanically held.

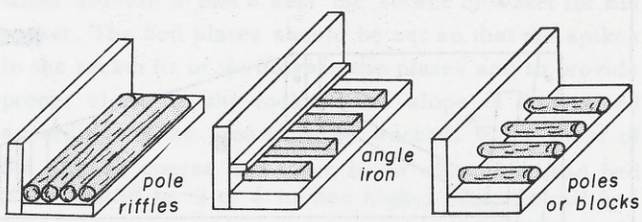
In sluicing, much of the manual labor done in the preceding methods is eliminated, as the water does all of the carrying. The mining may be done by hydraulicking, or a stream of water may be allowed to fall over a bank, washing the material to the sluice. Sluicing requires more water than the methods previously described, the amount ranging from 20 to 80 cubic feet of water to transport 1 cubic foot of gravel. Coarse gravel requires more water than fine, but as the grade is increased the amount of water required is lessened. The capacity of the sluice box is governed by its grade and the amount of water available as well as by its dimensions. In ground sluicing a ditch is dug along bedrock containing natural irregularities that furnish pockets which catch the gold.



Side view of a sluice

Top view of a sluice

Sections of sluice



Various types of riffles. (One side cut away.)

Page 12 illustrates the various types of riffles that can be used in sluice box construction.

Dip-box

The dip-box is a modification of the sluice box and may be used where water is scarce and the grade is too low for an ordinary sluice. It is portable, being readily carried in an automobile. It will permit handling about as much dirt in a day as a rocker, if the larger stones are thrown out by hand.

The dip-box is simply a short sluice with a bottom of 1- by 12-inch lumber, to which are nailed sides of three-quarter-inch or 1 inch by 6 inch boards and a

lower end-piece 1 or 1½ inches high. To catch gold, the bottom of the box may be covered with burlap, canvas, or thin carpet. Over this, beginning 1 foot below the back end of the box, may be laid a strip of heavy wire screen of quarter-inch mesh (made from no. 13 or no. 14 wire) 1 foot wide by 3 feet long. Burlap and screen may be held in place by cleats along the sides of the box. The dip-box may be 6 to 8 feet long. Many who use it claim that practically all the gold will be saved in the first 3 feet. The box is given a steep grade by being set on small trestles, the one near the head end being about waist high and 6 inches to a foot higher than the lower one near the discharge end. The dip-box is used by dumping the sand and gravel, a small bucketful at a time, into the back of box, then pouring water over it from a dipper, bucket, or hose until the water and gravel are washed out of the box, discharging over the lower end. Gold will lodge mostly in the screen. Riffles may be placed in the lower part of the box to catch gold that passes the screen. Water should be poured gently into the box. The larger stones must be thrown out by hand, unless the box is fitted with a hopper or a grizzly.

Dry Placers

Placer deposits have been mined in the desert regions of southeastern California where very little water is available. Since in these arid regions conventional wet methods cannot be used to recover gold, dry methods employing air instead of water have been devised. Dry concentration is much slower and less efficient than wet concentration and can only be used with small, dry particles that can be moved by the force of air.

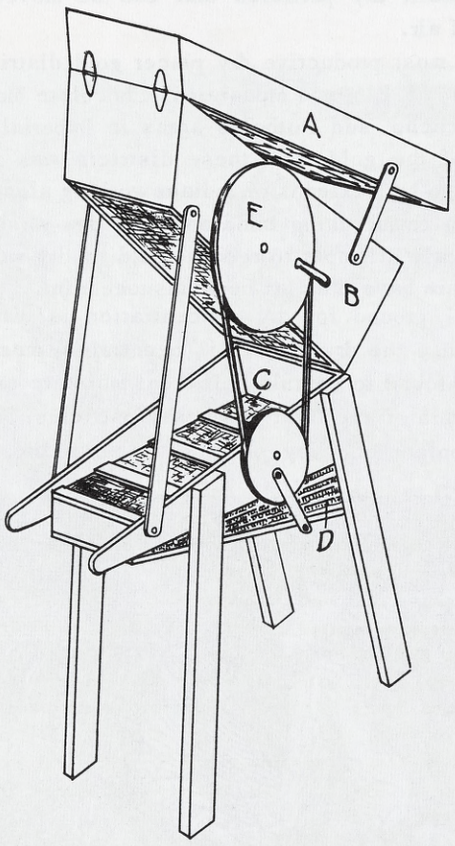
The most productive dry placer gold districts have been in the El Paso Mountains, Chocolate Mountains, and Picacho and Potholes areas in Imperial County. Much of the gold from these districts was produced years ago by Mexicans or Indians working alone or as a two-man team, using hand-operated dry washers. All large-scale attempts to recover gold by dry methods in California have thus far been unsuccessful.

Ideal ground for dry concentration is difficult to find. Once the dry surface is penetrated, most ground will be found to contain sufficient moisture to prevent separation of the light and heavy particles. The moisture content of "dry placers" thus is the principal

Winnowing gold.

obstacle to dry concentration.

Winnowing is the fundamental dry method. It involves screening out all the coarse gravel, placing the fines in a blanket and tossing them in the air in a strong wind. The lighter particles are blown away by the wind and the heavier more valuable minerals fall back onto the blanket. The weave of the blanket tends to hold the fine gold.



Dry Washer

A popular dry washer of the bellows type is shown in the accompanying figure. Here again the coarse particles must be separated out. This is accomplished by shoveling the gravel to be concentrated onto screen (A), where the coarse material passes off the low end of the screen, and the fines go into the hopper (B). From the low end of the hopper, the sand falls to the riffles (C). Air from the bellows (D) lifts the lighter particles of sand over the riffles and off the low end of the washer, while the heavier particles of gold and black sands remain back of the riffles.

The machine is operated by turning the crank (E) which is replaced with a small gasoline engine on some of the larger dry washers. The crankshaft is equipped with a cam to vibrate the screen, and a pulley wheel. The wheel transmits power by belt to an eccentric which operates the bellows.

Dry-washing gold

To insure a flat surface and an even distribution of air in the gold recovery section, a riffle unit is built up as follows: a well-braced heavy screen is covered with several layers of burlap, overlain by a piece of window or fly screen, and covered with handkerchief linen. Above this the riffles are placed from 4 to 6 inches apart. The riffles are made of 1/2-to 3/4-inch half-round moulding with the flat face on the upper side. If amalgamation of the flour gold is desired, pockets to hold quicksilver are placed in front of the riffles. Some flour gold also passes through the handkerchief linen and is caught in the burlap. A power washer of this type can handle up as much as 0.8 cubic yard per hour. Hand-washers operated by two men have a capacity of 1 or more cubic yards per 8-hour shift, depending upon the size and nature of the gravel to be handled.

Puddling Box

If a muddy or clayey material is to be sluiced, the first box of the string is made into a "puddling box." This can be 3 feet wide by 6 feet long, or any convenient dimensions, with 6-inch or 8-inch sides, and no riffles. The clayey material is shoveled into this box and broken up with a hoe or rake before it passes into the main sluice, as unbroken lumps of clay in a sluice may pick up and carry away the gold particles.

Riffles

Riffles are obstacles placed along the bottom of a sluice that form pockets to catch gold by concentrating the heavier materials. Numerous forms of riffles have been devised.

Common or slat riffles are strips of wood, iron, or steel extending across the sluice box. The abrasion is so great on wooden riffles that replacement is required often and therefore other types of riffles are preferred in large-scale operations.

Pole riffles frequently are used. These are 2- to 4-inch peeled poles placed either across or lengthwise in the sluice box. This type is used with coarse material and is efficient in concentrating both coarse and fine gold.

Block riffles are made by paving the floor of the sluice box with wooden blocks cut across the grain, about 4 inches or more high depending on the depth and width of the sluice. A narrow slat is nailed to each row of blocks. The rows are set in the trough so that the slats make contact with the floor of the trough. In this manner a space is left between the rows of blocks, forming the riffles. The blocks may be made either square or round. This method is good for both coarse and fine material.

Rock or stone riffles are made by paving the floor of the sluice with rock, either stream pebbles or flat stones quarried for the purpose. They are held in place by strips of wood nailed across the bottom at intervals. This method is good for fine and coarse material, and is especially good for cemented gravel.

Zig-zag riffles are slats placed part way across the floor of the sluice box alternately from the sides. This type is good for fine material as it concentrates gold in a manner similar to panning.

An undercurrent is a wide flat sluice placed beneath the main sluice box and is used for the purpose of saving the fine gold. It is usually 5 to 20 times as wide as the main sluice and from 10 to 50 feet long. It receives its feed from a grizzly or screen placed in the floor of the main sluice box, through which the fine material drops into a trough that distributes the feed evenly across the width. Undercurrents usually have a greater slope than the main sluice, because the shallow stream is more retarded by friction.

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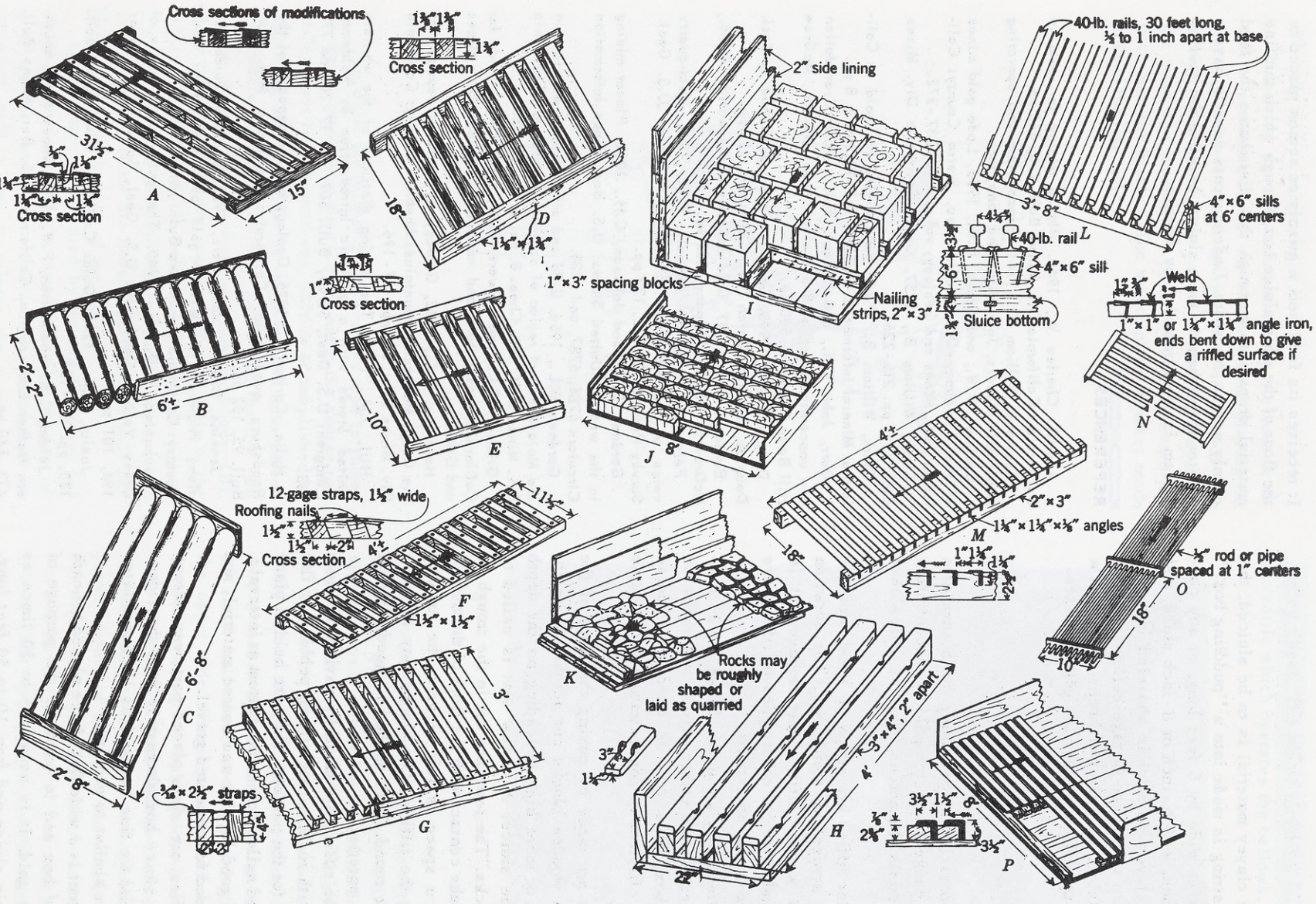

Types of riffles: *A*. Transverse wooden, steel-capped riffles used on dredges. *B*. Transverse pole riffles. *C*. Longitudinal pole riffles. *D*. Transverse wooden riffles, square section. *E*. Transverse wooden riffles, beveled section. *F*. Transverse wooden riffle, steel-capped, inclined section. *G*. Transverse wooden riffles, steel clad, with overhang. *H*. Longitudinal wooden riffles capped with cast-iron plates. *I*. Wooden-block riffles for large sluices. *J*. Wooden-block riffles for undercurrents. *K*. Stone riffles. *L*. Longitudinal rail riffles on wooden sills. *M*. Transverse angle-iron riffles. *N*. Transverse angle-iron riffles with top tilted upward. *O*. Longitudinal riffles made of iron pipe. *P*. Transverse cast-iron riffles used in undercurrents.

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GOLD AMALGAMATION

CONTENTS

ILLUSTRATIONS

Amalgamation is one of the oldest and simplest methods for recovering gold. When clean particles of gold are brought into contact with mercury, they form an alloy that is known as amalgam. The process is used to recover free gold in both lode and placer mining. In large-scale placer mining, the gold is amalgamated in sluices, riffle tables, or mechanical amalgamators. In small-scale placer mining, it is done in sluices or pans. In milling of lode-gold ores, the finely ground ore is amalgamated on plates or it is jigged, and the jig concentrates are amalgamated. The gold is separated from the mercury by heating or by retorting where the mercury is recovered and used over again. Mercury can be purchased from chemical supply houses and hardware or other stores that deal in miners' supplies. It usually comes in stoneware bottles or jugs, and it should be kept only in these or in iron or glass containers because of its tendency to amalgamate with other metals. Only clean mercury should be used in amalgamating. Mercury is cleaned by retorting or straining through cloth or chamois skin.

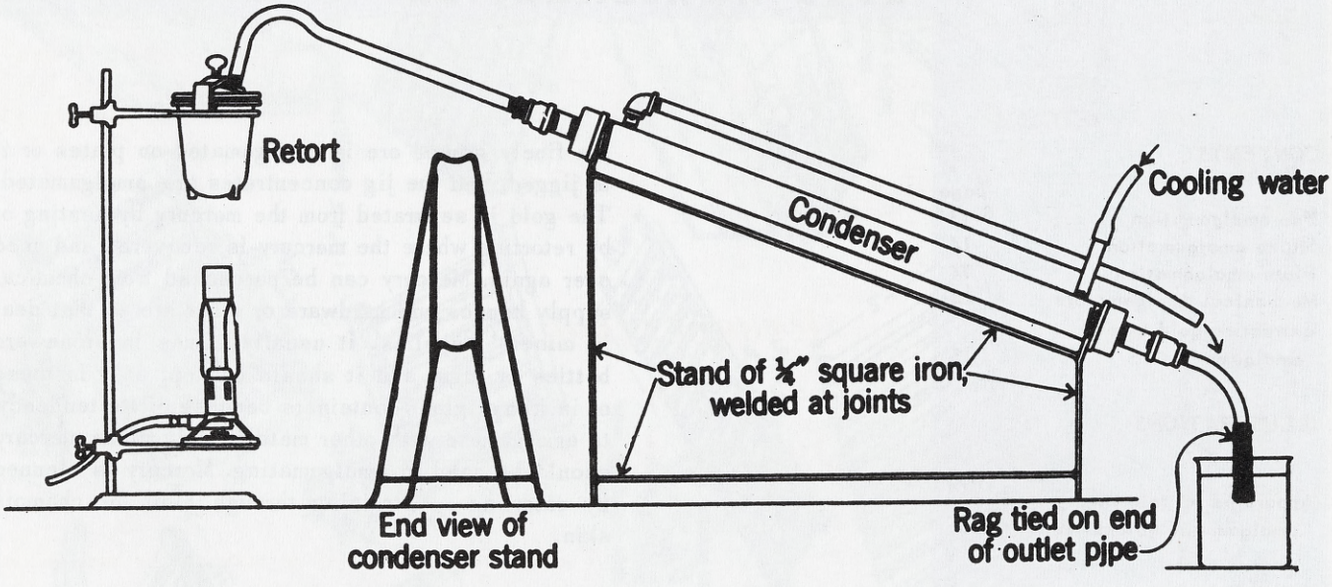
Pan amalgamation. A small quantity of mercury is placed in an ordinary miner's pan with the concentrates and agitated under water until no more free gold can be observed. The waste sands are then panned off, care being taken not to lose any of the amalgam or fine drops of mercury which gradually run together into a single mass. During the amalgamation process, the gold gradually loses its color and becomes more brittle. The amalgam is a dull grayish-white pasty mass which varies in hardness and color

according to the time of contact and size of the gold particles. Copper plated or copper bottomed pans are very useful for amalgamating. The copper should be cleaned thoroughly, and then mercury rubbed into it until it has a bright shiny surface. Then the concentrates are added and agitated. As the amalgam forms it should be scraped off and more mercury added to keep the surface bright.

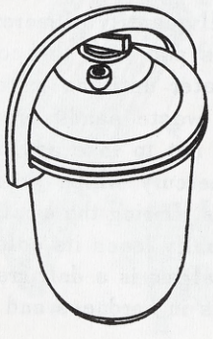
Sluice amalgamation. Mercury is carefully placed in the sluice boxes, where it finds its way into the riffles. All cracks and leaks in the sluice should be plugged. Some operators place mercury in the sluices before making a run, while others do it just before cleaning up. During the run more mercury should be added periodically. There will always be some loss, especially where the grade is steep. The sluice box concentrates are then removed, washed, and the amalgam and mercury recovered by panning.

Plate amalgamation. Amalgamating plates are used chiefly in lode-gold milling, but occasionally they are used in placer mining. In this process finely ground ore in the form of a thin pulp containing 25% or less solids passes over the plates which are set at a slight slope. The plates are composed of copper or silver-plated copper into which mercury has been worked to form a bright surface. As the amalgam accumulates, it is scraped off, and more mercury is added.

Mechanical amalgamators. There are a number of different types, but the most common are barrel amalgamators and pan amalgamators. These are used chiefly for cleaning up, but also they are useful for recovering fine gold from black sands. Amalgamating barrels are revolving steel or cast iron drums. The material to be treated is placed in the barrel with mercury, water, and a few iron or steel balls, and the barrel is turned slowly for an hour or two. It is then washed to remove the lighter material, and the amalgam and mercury are recovered by panning. Sometimes a weak solution of sodium cyanide is used to brighten the gold, but it should only be done by an experienced



Apparatus for retorting amalgam and quicksilver.



Water-sealed vapor trap.

Set-up of small retort.

person because of the danger of poisoning. Occasionally quartz pebbles are used to clean the rusty gold. Pan amalgamators are flat-bottomed cylindrical tubs or barrels upon which metal shoes slide. The concentrate and mercury are placed in the pan with enough water to make the mass fluid and the device is run 1 or 2 hours. Revolving cast iron bowls containing heavy balls occasionally are used. A small concrete mixer with round cobblestones is a convenient amalgamating device for the small- or medium-scale placer miner.

Extracting gold from amalgam. The gold-bearing amalgam should first be cleaned. This is done by washing and then straining out excess mercury through buckskin, chamois skin, or strong tight cloth such as canvas. All of this usually is done by hand and preferably under water. The clean amalgam is then heated or retorted to drive off the mercury, and gold sponge remains. Whenever amalgam is heated, great care should be taken to avoid inhaling the mercury fumes as they are exceedingly poisonous. Do not heat mercury or amalgam inside a house or any closed area.

If only a small amount is to be treated, the amalgam is heated on a flat iron surface such as a shovel until all of the mercury is driven off. A simple method for treating small amounts of amalgam and recovering the mercury is to heat the amalgam under half of a hollowed-out potato. The mercury condenses in the potato which later is crushed and panned for recovery of the mercury. Small amounts can also be retorted in a glass tube that is sealed and bent at one end. The amalgam is placed in the sealed end and heated, the mercury fumes condensing in the open end.

A typical retort that is used in many mining operations is a cast iron pot with a tight-fitting cover. The cover has a hole that is connected with the condenser pipe (see figure). Capacities of these range from a few to several hundred pounds of amalgam. The condenser is an iron pipe 3 or 4 feet long which is encased in a larger pipe through which cooling water circulates. The inside of the pot is usually coated with a thin film of chalk, clay, or a mixture of clay and graphite to prevent gold from sticking to the iron, and it should be thoroughly dried before adding the charge. The retort is filled with amalgam to not over 2/3 of capacity. The cover is clamped on, and the retort is heated. A low heat is first applied and then increased just enough to allow the mercury to vaporize and condense. A steady trickle of mercury emerges from the pipe which discharges into a vessel. When no more mercury appears, the temperature is increased for a few minutes to drive the last of the mercury out of the retort. It then is allowed to cool. The spongy mass of gold left after retorting can be sold to the U.S. mint or a licensed gold buyer. No more than 200 ounces of retort sponge may be held by any unlicensed person in the United States at any time.

Prospecting for Quartz Veins

This brief article is primarily intended for those who have recently become interested but are not familiar with this method of prospecting.

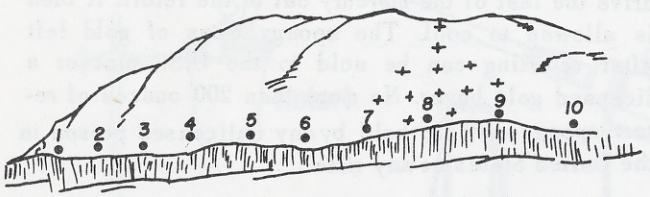
The first requisite is to learn to use a miner's pan. Practice with a small grease-free frying pan. In the absence of a regulation gold-pan, a frying pan can be made to answer for all practical purposes. (See "Elementary placer mining methods" for instructions on pan operations.)

A gold-bearing vein may or may not be visible on the surface. During its slow process of breaking down, gold becomes scattered in the soil, usually close to or on the bed-rock below the vein. The movement of gold eroded from a vein is like the flow of water.

For example, visualize a small vein of gold-ore occurring on a hillside and running in a direction nearly parallel to the base of the hill. If, at a point about twenty feet below, and on a line parallel to this vein, a number of samples five or ten feet apart be taken by digging down to or nearly to bedrock, they will likely yield gold colors in panning. (A color is

one visible flake, or speck of gold.) On a line forty feet below, and parallel to the vein, samples taken in the same manner may also give gold colors, *but* they will probably be fewer in number to the pan. At sixty, or perhaps as far as two hundred feet below, colors might still be obtained. In searching for a gold deposit conditions are reversed: the source is unknown, but the finding of colors is an indication of the existence of a gold-bearing vein at some higher point.

In prospecting a hill, holes are usually dug near its base at intervals of fifty feet or more, and the alluvium near bed-rock is panned carefully. When colors are found, the prospector ascends about twenty feet where he digs more holes in a line parallel to the first row. He pans samples on this line and then climbs about twenty feet higher and starts his new line of holes over the point where he obtained his best sample. He is attempting to follow the gold flow to its source by picking up in his pan little specks of the scattered metal. This method of prospecting is called "post-holing" on account of its resemblance to digging such holes to obtain samples.



Prospecting a hillside. Beginning at dot No. 1 a sample was taken, and then every 50 or 100 feet. At point 8 the best prospect was found. Samples were then taken as represented by + until the crest of the hill was reached; in this case the vein was rich, but did not crop out.

Gold can usually be found on the bedrock of creeks or gullies in gold-bearing regions. To search for gold in a dry creek, find a place in the watercourse where the bedrock is exposed or nearly exposed. Gold lodges under large rocks and in cracks in the solid formation. Find a fracture in the bedrock. Pry it open with a pick or bar. Your pan filled with water should be handy. Lift out the rocks as they are broken, and wash them in the pan scraping off any adhering clay or sand. Scrape up all the sand from the crevice and place it in the pan. A small paint brush, a spoon and an old table or putty knife are useful in scraping up all the fine sand that might be lodged in a crevice or under a boulder. Scrape the bedrock vigorously and brush up the sand and dust carefully, for the gold flakes sink deeply. Sometimes three or more scrapings from different parts of the creek may be obtained for one panning test. Pan very carefully. If gold is found, ascend the watercourse and continue to pan at spacings of fifty feet or more. When a point is reached where panning does not yield colors, or the amount of colors greatly diminishes, go back to where it was last obtained and "post-hole" on the hillside.

With a pencil and paper one could outline the probable course of quartz or float from a vein and plan the finding of the deposit by tracing the castoff flakes of gold or pieces of quartz.

Disintegrated quartz that has separated from its vein and become scattered, follows a course like that of the foregoing described gold, only it is likely to travel farther in its downward course. Quartz float can be traced to its source by careful observation.

In testing quartz for gold, pulverize a small amount to the fineness of sand. A small mortar and pestle is necessary for such testing. A large handful of fines will be necessary. Pan very carefully.

Learn to identify quartz. Use a magnetized knife-blade to remove fragments of iron. Have any heavy unknown mineral found in panning identified, but try to learn to identify the nearly black grains of iron oxides. Have quartz that contains fine-grained pyrite or lead minerals assayed for gold.